

National Advisory Committee for Aeronautics

Research Abstracts

NO. 30

OCTOBER 9, 1952

CURRENT NACA REPORTS

NACA Rept. 1024

National Advisory Committee for Aeronautics.
CALCULATION OF THE LATERAL CONTROL OF
SWEEP AND UNSWEEP FLEXIBLE WINGS OF AR-
BITRARY STIFFNESS. Franklin W. Diederich.
1951. ii, 19p. diags., 6 tabs. (NACA Rept. 1024.
Formerly RM L8H24a)

A method similar to that of NACA Rept. 1000 is pre-
sented for calculating the effectiveness and the re-
versal speed of lateral-control devices on swept and
unswept wings of arbitrary stiffness. Provision is
made for using either stiffness curves and root-
rotation constants or structural influence coefficients
in the analysis. Computing forms and an illustrative
example are included to facilitate calculations by
means of the method. The effectiveness of conven-
tional aileron configurations and the margin against
aileron reversal are shown to be relatively low for
swept wings at all speeds and for all wing plan forms
at supersonic speeds.

NACA Rept. 1046

National Advisory Committee for Aeronautics.
A GENERAL INTEGRAL FORM OF THE BOUNDARY-
LAYER EQUATION FOR INCOMPRESSIBLE FLOW
WITH AN APPLICATION TO THE CALCULATION OF
THE SEPARATION POINT OF TURBULENT BOUND-
ARY LAYERS. Neal Tetervin and Chia Chiao Lin.
1951. 19p. diags. (NACA Rept. 1046. Formerly
TN 2158)

A general integral form of the boundary-layer equa-
tion, valid for either laminar or turbulent incom-
pressible boundary-layer flow, is derived. By using
the experimental finding that all velocity profiles of
the turbulent boundary layer form essentially a
single-parameter family, the general equation is
changed to an equation for the space rate of change of
the velocity-profile shape parameter. The lack of
precise knowledge concerning the surface shear and
the distribution of the shearing stress across turbu-
lent boundary layers prevented the attainment of a
reliable method for calculating the behavior of turbu-
lent boundary layers.

NACA Rept. 1056

National Advisory Committee for Aeronautics.
THEORETICAL ANTISYMMETRIC SPAN LOADING
FOR WINGS OF ARBITRARY PLAN FORM AT SUB-
SONIC SPEEDS. John DeYoung. 1951. 36p.
diags., 9 tabs. (NACA Rept. 1056. Formerly
TN 2140)

A simplified lifting-surface theory that includes
effects of compressibility and spanwise variation of
section lift-curve slope is used to provide charts
with which antisymmetric loading due to arbitrary
antisymmetric angle of attack can be found for wings
having symmetric plan forms with a constant span-
wise sweep angle of the quarter-chord line. Aero-
dynamic characteristics due to rolling, deflected ai-
lerons, and sideslip of wings with dihedral are con-
sidered. Solutions are presented for straight-tapered
wings for a range of swept plan forms.

NACA Rept. 1066

National Advisory Committee for Aeronautics.
ANALYSIS OF TEMPERATURE DISTRIBUTION IN
LIQUID-COOLED TURBINE BLADES. John N. B.
Livingood and W. Byron Brown. 1952. ii, 21p.
diags. (NACA Rept. 1066. Formerly TN 2321)

Analytical methods are presented for computing tem-
perature distributions in liquid-cooled turbine blades
or in simplified shapes used to approximate sections
of liquid-cooled turbine blades. Nondimensional
charts are presented for use in the simplification of
some of the calculations. Illustrative examples are
also included to demonstrate the use of the various
equations and nondimensional charts and to show
trends of the various temperature distributions.
One-dimensional spanwise temperature distributions
gave satisfactory results near the coolant passages.
One-dimensional chordwise distribution gave a good
first approximation to the actual solution in cases
when rim cooling was insignificant.

NACA TN 2734

National Advisory Committee for Aeronautics.
SUMMARY OF AVAILABLE HAIL LITERATURE AND
THE EFFECT OF HAIL ON AIRCRAFT IN FLIGHT.
Robert K. Souter and Joseph B. Emerson.
September 1952. 162p. diags., photos., 6 tabs.
(NACA TN 2734)

Available information on the hail phenomenon affect-
ing aircraft in flight has been examined. This paper
attempts to coordinate the present knowledge of hail

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THE REPORT TITLE AND AUTHOR.

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2158i

with the effect of hail on aircraft in flight and includes (1) a digest of the literature on the physical properties, the occurrence, and the formation of hail; (2) a survey of the hail effect on aircraft in flight from analyses of 57 cases of airplanes damaged by hail; (3) a résumé of hail information for the benefit of pilots, forecasters, and ground operational personnel; and (4) an annotated hail bibliography of 552 articles for use of research personnel.

NACA TN 2765

A FLIGHT INVESTIGATION OF THE EFFECT OF SHAPE AND THICKNESS OF THE BOUNDARY LAYER ON THE PRESSURE DISTRIBUTION IN THE PRESENCE OF SHOCK. Eziaslav N. Harrin. September 1952. 13p. diags., photos. (NACA TN 2765)

An investigation was made in flight at free-stream Mach numbers up to about 0.77 to determine the effect of a laminar boundary layer and thin and thick turbulent boundary layers on the chordwise pressure distribution over an airfoil in the presence of shock at full-scale Reynolds numbers. Boundary-layer and pressure-distribution measurements were made on a short-span airfoil built around a wing of a fighter airplane. Boundary-layer Reynolds numbers (based on momentum thickness and flow parameters at the outer edge of the boundary layer) were about 3,000 for the laminar boundary layer and 10,000 for the thickest turbulent boundary layer with local Mach numbers ranging up to 1.3 and chord Reynolds numbers up to about 21×10^6 .

NACA TN 2773

AN APPROXIMATE METHOD FOR DETERMINING THE DISPLACEMENT EFFECTS AND VISCOUS DRAG OF LAMINAR BOUNDARY LAYERS IN TWO-DIMENSIONAL HYPERSONIC FLOW. Mitchel H. Bertram. September 1952. 41p. diags., photos., tab. (NACA TN 2773)

A simplified approximate theory is presented by means of which the laminar boundary layer over an insulated two-dimensional surface may be calculated, a linear velocity profile being assumed, and an estimate made of its effect in changing the pressure distribution over the profile upon which the boundary layer is formed. Skin friction is also determined. Comparisons of results from this theory are made with experimental results at a Mach number of 6.86 and a Reynolds number of 980,000.

NACA TN 2780

FLIGHT INVESTIGATION OF TRANSIENT WING RESPONSE ON A FOUR-ENGINE BOMBER AIRPLANE IN ROUGH AIR WITH RESPECT TO CENTER-OF-GRAVITY ACCELERATIONS. Harry C. Mickleboro, Richard B. Fahrner and C. C. Shuffelbarger. September 1952. 25p. diags., 3 tabs. (NACA TN 2780)

The results of a flight investigation on a four-engine bomber airplane to determine the transient-response effects of wing flexibility in gusts showed that the measured acceleration increments at the center of gravity were approximately 28 percent higher than the true airplane acceleration increments. This relationship appeared to be only slightly affected by the variations in speed and weight covered by the test conditions.

NACA TN 2783

USE OF A CONSOLIDATED POROUS MEDIUM FOR MEASUREMENT OF FLOW RATE AND VISCOSITY OF GASES AT ELEVATED PRESSURES AND TEMPERATURES. Martin B. Biles and J. A. Putnam, University of California. September 1952. 51p. diags., photos., 7 tabs. (NACA TN 2783)

Use of a consolidated porous medium as a gas-metering device and for determination of gas viscosity has been investigated over a moderate range of temperature and pressure. With normal laboratory techniques it appears possible to calibrate large porous Alundum filtering thimbles to meter gas with a probable error of 0.1 to 0.2 percent. The geometry of such elements permits an appreciable range of gas flow rate to be metered with small, accurately controlled, pressure drops. The advantages of such a device warrant its use as a laboratory instrument. Results of the flow tests have been employed in the determination of the viscosity of air up to approximately 900 pounds per square inch absolute at the two test temperatures of 75° and 517° F. These data appear to check sufficiently well with other published viscosity data to justify the use of this method as a recommended procedure.

NACA TN 2784

METHOD FOR CALCULATION OF COMPRESSIBLE LAMINAR BOUNDARY-LAYER CHARACTERISTICS IN AXIAL PRESSURE GRADIENT WITH ZERO HEAT TRANSFER. Morris Morduchow and Joseph H. Clarke, Polytechnic Institute of Brooklyn. September 1952. 43p. diags., 4 tabs. (NACA TN 2784)

The Kármán-Pohlhausen method is extended primarily to sixth-degree velocity profiles for determining the characteristics of the compressible laminar boundary layer over an adiabatic wall in the presence of an axial pressure gradient. It is assumed that the Prandtl number is unity and that the coefficient of viscosity varies linearly with the temperature. A general approximate solution which permits a rapid determination of the boundary-layer characteristics for any given free-stream Mach number and given velocity distribution at the outer edge of the boundary layer is obtained. A simple method based on the use of a seventh-degree velocity profile is derived for the special purpose of calculating the location of the separation point in an adverse pressure gradient. It is shown that for the special case of flow near a forward stagnation point the Kármán-Pohlhausen method with the usual forth-degree profiles leads to results of adequate accuracy, even for the critical Reynolds number.

NACA TN 2785

INTRODUCTION TO ELECTRICAL-CIRCUIT ANALOGIES FOR BEAM ANALYSIS. Stanley U. Benscoter and Richard H. MacNeal, California Institute of Technology. September 1952. 48p. diagrs., 5 tabs. (NACA TN 2785)

An application is described of the well-known analogy between electrical and mechanical systems to the calculation of stresses and deflections of beams. The object of the present paper is to give an explanation of the analogies in an elementary manner which will enable a structural engineer to understand the process of designing the electrical circuits. The analogies which are discussed are those that are now being used in the Cal-Tech analog computer. Analogies are given for beams in bending and torsion with static loads and in vibrational motion.

NACA TN 2786

EQUIVALENT PLATE THEORY FOR A STRAIGHT MULTICELL WING. Stanley U. Benscoter and Richard H. MacNeal, California Institute of Technology. September 1952. 32p. diagrs. (NACA TN 2786)

A structural theory is developed for the analysis of thin multicell wings with straight spars and perpendicular ribs. The analysis is intended to be suitable for supersonic wings of low aspect ratio. Deflections due to shearing strains are taken into account. The theory is expressed entirely in terms of first-order difference equations in order that analogous electrical circuits can be readily designed and solutions obtained on the Cal-Tech analog computer.

NACA TN 2787

AIRFOIL PROFILES FOR MINIMUM PRESSURE DRAG AT SUPERSONIC VELOCITIES - APPLICATION OF SHOCK-EXPANSION THEORY, INCLUDING CONSIDERATION OF HYPERSONIC RANGE. Dean R. Chapman. September 1952. 44p. diagrs. (NACA TN 2787)

A theoretical investigation employing shock expansion theory is made of the airfoil profile having minimum pressure drag at zero lift for various given auxiliary conditions. Curves are presented to facilitate the application of the theory, and typical optimum profiles are illustrated. A comparison of results obtained by the simpler linearized-theory method of a previous report indicates that the simpler method can be used with engineering accuracy to determine the shape, though not the drag, of the optimum profile at Mach numbers up to infinity. It is shown that considerable deviation from the optimum shape can be made without a large increase in drag except on thin airfoils at moderate supersonic Mach numbers.

NACA TN 2788

EFFECTS OF SOLVENTS IN IMPROVING BOUNDARY LUBRICATION OF STEEL BY SILICONES. S. F. Murray and Robert L. Johnson. September 1952. 23p. diagrs., 2 tabs. (NACA TN 2788)

Because of the known synthetic fluids, silicones best satisfy the viscometric requirements for lubricants for turbine engines, a study was conducted to establish the effect of solvents on boundary lubrication by silicones. Boundary-lubrication data were obtained which are considered substantiating evidence for a hypothesis that, in solutions of solvents blended with silicones, the silicones form a closely packed and oriented adsorbed film on ferrous surfaces. The solutions reduced friction and prevented surface failure even when the solvent as well as the silicone was an extremely poor lubricant. These data indicate that satisfactory lubrication is the result of a solvation effect rather than a lubrication additive effect of the solvent because 30 to 50 percent of solvent was necessary for good results. The best results were obtained with solvents having dipole moments. Solutions of diesters in silicones may be practical lubricants.

NACA TN 2789

SOME DYNAMIC EFFECTS OF FUEL MOTION IN SIMPLIFIED MODEL TIP TANKS ON SUDDENLY EXCITED BENDING OSCILLATIONS. Kenneth F. Merten and Bertrand H. Stephenson. September 1952. 35p. diagrs., photos., 2 tabs. (NACA TN 2789)

An exploratory investigation of the dynamic effects of fuel sloshing in tip tanks on wing bending motion was conducted with two simplified model beam-tank systems. Envelope curves to beam-displacement-time histories obtained after release from a deflected position are compared and show the effects of variation in tank fullness, fluid density, fluid viscosity, and tank shape. Some variations of fluid weight effective from cycle to cycle are also presented. The results of these tests indicate that after several cycles substantial damping may be obtained from fuel sloshing in a tip tank and that the effective mass of the fuel may vary considerable under certain conditions of tank oscillation. The viscosity of the fluid did not affect the damping or inertia characteristics obtained but, for a given beam-tank system, the density of fluid and tank fullness were important parameters.

NACA TN 2791

CORRELATION OF TENSILE STRENGTH, TENSILE DUCTILITY, AND NOTCH TENSILE STRENGTH WITH THE STRENGTH OF ROTATING DISKS OF SEVERAL DESIGNS IN THE RANGE OF LOW AND INTERMEDIATE DUCTILITY. Arthur G. Holms and Andrew J. Repko. September 1952. 30p. diagrs., 3 tabs. (NACA TN 2791)

Burst tests were conducted on several designs of sound disks and disks with defects and results were compared with tensile strength, tensile ductility, and notch tensile strength. For the brittle materials, the disk strength did not correlate with tensile strength. For the brittle materials and for ductile materials for which notch strength data were available, the disk strength was found to correlate better with the combination of tensile strength and notch strength ratio than with the combination of tensile strength and elongation. For disks with defects, the notch tensile strength was superior to the conventional tensile strength.

NACA TN 2793

A METHOD FOR THE DETERMINATION OF THE TIME LAG IN PRESSURE MEASURING SYSTEMS INCORPORATING CAPILLARIES. Archibald R. Sinclair and A. Warner Robins. September 1952. 35p. diags., tab. (NACA TN 2793)

A method is presented for the determination of the time lag in pressure measuring systems incorporating capillaries; this method is a convenient and systematic means of selecting, designing, or redesigning a pressure measuring system to meet the time requirements of a particular installation. Experimental data are shown and a step-by-step sample application is presented.

NACA TN 2795

EFFECTS OF WING SWEEP ON THE UPWASH AT THE PROPELLER PLANES OF MULTIENGINE AIRPLANES. Vernon L. Rogallo. September 1952. 46p. diags. (NACA TN 2795)

An analysis is presented to give a qualitative picture of the effects of wing sweep on the upwash at the propeller planes of multiengine airplanes. In order to provide a basis for judging effects of sweep, comparisons are made of the upwash and upflow angles at the propeller planes of two hypothetical airplanes of the high-speed long-range type, one having an unswept wing and the other a sweptback wing. The effects of compressibility are considered. Charts are provided to enable the prediction of upwash in the chord-plane region ahead of wings of various plan forms.

NACA RM E52B12

IMPINGEMENT OF WATER DROPLETS ON AN NACA 65₁-212 AIRFOIL AT AN ANGLE OF ATTACK OF 4°. Rinaldo J. Brun, John S. Serafini and George J. Moshos. September 1952. 47p. diags., tab. (NACA RM E52B12)

The trajectories of droplets in the air flowing past an NACA 65₁-212 airfoil at an angle of attack of 4° were determined. The collection efficiency, the area of droplet impingement, and the rate of droplet impingement were calculated from the trajectories. The results are applicable under the following conditions:

chord lengths from 2 to 20 feet, altitudes from 1000 to 35,000 feet, airplane speeds from 150 miles per hour to the critical flight Mach number, and droplet diameters from 5 to 100 microns.

NACA RM E52H15

PRESSURE LIMITS OF FLAME PROPAGATION OF PURE HYDROCARBON-AIR MIXTURES AT REDUCED PRESSURES. Adolph E. Spakowski. September 1952. 35p. diags., 2 tabs. (NACA RM E52H15)

An investigation was made of the pressure concentration limits of flame propagation in glass tubes for 18 high-boiling hydrocarbons mixed with air. The concentration limits were correlated with molecular weight. Relations were also derived between the flammability range and the molecular weight and between the rich and lean limits.

NACA RM L52G18

INVESTIGATION OF THE EFFECTS OF VARIATIONS IN THE REYNOLDS NUMBER BETWEEN 0.4×10^6 AND 3.0×10^6 ON THE LOW-SPEED AERODYNAMIC CHARACTERISTICS OF THREE LOW-ASPECT-RATIO SYMMETRICAL WINGS WITH RECTANGULAR PLAN FORMS. George W. Jones, Jr. September 1952. 13p. diags. (NACA RM L52G18)

The effects of Reynolds number on the aerodynamic characteristics of three symmetrical wings of aspect ratio 1, 2, and 3 each having a rectangular plan form and an NACA 0012 airfoil section is given for a range of seven Reynolds numbers between 0.4×10^6 and 3.0×10^6 . The data show the effects of Reynolds number on the lift, the lift-curve slope, maximum lift coefficient, and the pitching moment about the quarter-chord point.

NACA TM 1337

ANALYTICAL STUDY OF SHIMMY OF AIRPLANE WHEELS. (Étude Théorique du Shimmy des Roues d'Avion). Christian Bourcier de Carbon. September 1952. 126p. diags., photos. (NACA TM 1337. Trans. from Office National d'Etudes et de Recherches Aéronautiques, Pub. 7, 1948).

The problem of shimmy of a castering wheel, such as the nose wheel of a tricycle gear airplane, is treated analytically. The flexibility of the tire is considered to be the primary cause of shimmy. The rather simple theory developed agrees rather well with previous experimental results. The author suggests that shimmy may be eliminated through a suitable choice of landing gear dimensions in lieu of a damper.

BRITISH REPORTS

N-17089*

Aeronautical Research Council (Gt. Brit.)
TWO-DIMENSIONAL WIND TUNNEL INTERFER-
ENCE. L. G. Whitehead. June 17, 1950. 24p.
diags. (ARC 13, 198; FM 1451)

The present paper describes a contribution to the theory of two-dimensional wind-tunnel interference on bodies set at zero incidence in the center of the flow. The work is limited to incompressible flow. The irrotational flow has been found between parallel walls and also in a free jet past two cylindrical sections. The first of these is a circular cylinder and the second is a slender profile with a uniform pressure drop over the greater part of the boundary. No account is taken of the wake which exists behind a body in a real fluid so that the tunnel interference represented in the present paper is that usually referred to as solid blockage and the effects of wake blockage are not considered. The free streamline method is employed for the calculation of the flow of a jet past both bodies so that the outward displacement of the streamline is correctly represented and the approximations associated with the application of the method of images to these problems are avoided. The results are not limited therefore to examples in which the profile dimensions are small compared with the width of the jet. The free streamline method has an additional advantage as the solutions can readily be adapted to deal with problems in which the outer boundaries of the flow consist partly of parallel walls and partly of free streamlines.

N-17091*

Aeronautical Research Council (Gt. Brit.)
THE LAMINAR AXI-SYMMETRIC JET: EXACT
SOLUTION. H. B. Squire. July 22, 1950. 7p.
diags. (ARC 13, 267; FM 1462)

A solution of the flow in a laminar axisymmetric jet was given by Schlichting in 1933, making use of the approximations of boundary-layer theory. The corresponding exact solution of the Navier-Stokes equations is derived in the present report. It is also shown that this solution can be interpreted as the flow resulting from a force applied at a point in a viscous fluid which is at rest at infinity.

N-17099*

Forest Products Research Lab. (Gt. Brit.)
TRIALS OF TIMBER FOR PLYWOOD MANUFACTURE. PRELIMINARY REPORT ON SIX AFRICAN SPECIES. PROGRESS REPORT SEVENTEEN.
June 1952. 28p. 15 tabs. (Forest Products Research Lab.)

This report describes tests on six African species of wood to determine their suitability for plywood manufacture. The following species were tested: berlinia, brown sterculia, kokrodua, mguma, pterygota, and yellow sterculia.

N-17109*

National Gas Turbine Establishment (Gt. Brit.)
SOME EXPERIMENTS ON BREAKDOWN POTENTIAL
IN HOT PRODUCTS OF COMBUSTION. N. A.
Dimmock. May 1952. 14p. diags., tab. (NGTE
Memo. M. 153)

The experiments described in this memorandum show that no general lowering of the breakdown potential is caused by the ionization present in the exhaust gases from a combustion chamber, although a slight drop in its value is noticeable very close to the chamber exit. The fuels used were aviation kerosene, gas oil (Marine reference B. 310) and gas oil with n-Butyl disulphide. The ceramic insulator used in the experiments was found to become semiconducting at elevated temperatures and this trouble would have to be overcome in designing an electrode for a hot gas electrostatic-cleaner.

N-17172*

Royal Aircraft Establishment (Gt. Brit.)
MEASUREMENT OF THE MOISTURE CONTENT OF
HIGH PRESSURE OXYGEN FOR USE IN AIRCRAFT.
I. A LOW PRESSURE HYGROMETER. M. E.
Bedwell and W. G. Glendinning. March 1952. 9p.
diags., 3 tabs. (RAE Tech. Note Chem. 1154)

A hygrometer has been devised which will give precise measurement of the moisture content of oxygen issuing from a cylinder. Test runs on samples from transport cylinders indicate that in every case the oxygen contained considerably less than the maximum amount of moisture allowed by specification. No anomalous changes of moisture content with decreasing pressure were observed in the cylinders selected.

N-17304*

Royal Aircraft Establishment (Gt. Brit.)
FREQUENCY REGULATOR FOR A MOTOR-
ALTERNATOR. C. S. Hudson. January 1952.
17p. diags., photo. (RAE Tech. Note EL. 30)

The design of a frequency regular for a 2 kw 333 cps motor alternator is described and details given of the experimental measurements made. A two stage magnetic amplifier is used having a current gain of about 3000 and a power amplification of about 10^8 . The design is intended to give regulation to within 0.1 percent; from approximate measurements made it is considered to be better than 0.3 percent. No attempt has been made to examine the stability of the frequency reference circuit and further work on this needs to be done.

N-17305*

Royal Aircraft Establishment (Gt. Brit.)
SOME MEASUREMENTS OF TAKEOVER TIME LAGS
IN THE STRIKING OF COLD-CATHODE TRIODES.
J. C. Le Grice. March 1952. 16p. diags., photos.
(RAE Tech. Note EL. 32)

The design of time-delay circuits using cold-cathode triodes necessitated a knowledge of the magnitude of the takeover time by which striking of the anode circuit lags behind striking of the trigger circuit. A method of applying the trigger and anode voltage wave forms to the deflection plates of a C. R. O. is described which enabled the takeover time to be measured between the attainment of currents of 10^{-3} amps in the trigger and anode circuits respectively. Some measurements on miniature triodes with potassium cathodes gave takeover times of less than 50 μ s for anode voltages between 100 and 200 volts. The takeover times were repeatable to better than 5 percent.

N-17314*

Royal Aircraft Establishment (Gt. Brit.)
TOWING TANK TESTS TO DETERMINE THE WATER DRAG AND PITCHING MOMENTS ON THE FINAL HULL FORM OF A LARGE FLYING BOAT SEAPLANE (PRINCESS, SPEC. 10/46). T. B. Owen and A. G. Kurn. April 1952. 33p. diagrs., photo., 5 tabs. (RAE Tech. Note Aero 2159)

The water drag, trim and hull wetted areas of the Princess flying boat hull model (final form) have been measured for all anticipated take-off weights and attitudes. The drag characteristics compare favorably with those obtained on other boat seaplanes. The measurements were made using new techniques for: model surface finish, drag measurements, and representation of the effect of air flow past the model. A method is given for correcting the model drag data to full scale to allow for the difference in Reynolds number.

